## Title page

# Association of increasing age with receipt of specialist care and long-term mortality in patients with non-ST elevation myocardial infarction

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**Key points**

We confirmed lesser receipt of specialist cardiologist care with older age in patients with NSTEMI.

Cardiologist care resulted in receipt of more secondary prevention medication in all age groups, though with increased age less secondary prevention was given by both cardiologists and generalists.

We found that increased co-morbidity could mostly explain the lesser use of secondary prevention medication in older patients by generalists.

In those aged 85 and over, the benefit of being under a cardiologist was attenuated significantly when adjusted for receipt of secondary prevention medication particularly for shorter (30 day) outcomes.

Any longer-term survival benefit associated with specialist cardiology care was attenuated with increased age itself.

## Abstract

*Background*

Older patients are less likely to receive secondary prevention medicines following acute coronary syndrome (ACS).

*Objectives*

To examine the association of increasing age with receipt of specialist care and influence of specialist care on long-term mortality in patients with non-ST elevation myocardial infarction (NSTEMI)

*Design*

Cohort study

*Setting*

National ACS registry of England and Wales

*Subjects*

85,183 patients between 2006-2010

*Methods*

Logistic regression analyses to assess receipt of secondary prevention medicines (ACE inhibitor, b-blocker, statin, aspirin) by age group; multivariate Cox Regression models to examine longitudinal effect of cardiologist care on all-cause mortality by age group.

*Results*

Mean age 72.0 years (SD 13.0 years), mean follow up was 2.13 years. Older patients received less cardiologist care (70.2% of NSTEMI patients ≥85 compared to 94.7% of patients <65) and had more co-morbidity. Cardiologists prescribed more secondary prevention in all age groups than generalists but this was mostly explained away by co-morbidity (receipt of statin crude OR 1.51 (1.27,1.80), fully-adjusted OR 1.11 (0.92,1.33) in patients ≥85). Receiving cardiologist care compared to generalist care was associated with a decreased risk of death in all even after adjustment for co-morbidity, disease severity, secondary prevention; this benefit reduced incrementally with older age group (adjusted hazard ratio (HR) 0.58 (0.49,0.68) aged <65; 0.87 (0.82,0.92) aged ≥85).

*Conclusion*

Older patients with NSTEMI were less likely to see a cardiologist, but reduced treatment by generalists was explained away by co-morbidity. Cardiologist care was associated with lower

mortality in all age groups than a generalist, but this survival benefit was less pronounced in older patients.

## Introduction

As the world ages,[1] the typical cardiology patient in most developed world acute hospitals is an older adult with around a third of patients aged 75 or over.[2] As risk of death after a cardiac event increases in older populations,[3-4] the absolute benefit of treatment should increase as well, provided the risks of the treatment itself does not exceed the benefit it is designed to provide.[5-6] However evidence from observational studies suggests that older patients are less likely to receive secondary prevention medicines following acute coronary syndrome (ACS).[7-9] This is despite such treatments being indicated, and being shown to be effective within a clinical trial setting even in the very old,[10-11] a risk-treatment paradox. Some have also previously suggested that older patients with coronary disease are less likely to receive care from a cardiologist.[12-14]

Given older patients have a higher number of co-morbidities,[15] and have a higher risk of complications (e.g., bleeding) after medical interventions for ACS,[16] it is not known whether the observed deficiency in indicated care relative to younger patients is appropriate; less treatment may be explained by contra-indications to treatment. The representation in clinical trial populations of older patients is much lower than in real-world clinical practice and community study populations,[2, 17] hence potentially rendering trial evidence on best practice in the older patient with ACS unrepresentative. Furthermore, a clinical trial that withheld secondary prevention medicines following ACS in older patients would be unethical. Large national clinical registries offer both representative study populations with high generalisability and statistical power and the appropriate study design to be able to analyse these questions.

Using national registry data from patients with a NSTEMI (non-ST elevation myocardial infarction), we explored the hypothesis that co-morbidities and peri-admission complications would affect receipt of secondary prevention medication and this would confound the influence of cardiologist versus generalist care on receipt of treatments, by age group. Then, we sought to examine the association of cardiologist care on all-cause mortality over generalist care, and sought to adjust for both receipt of care but also co-morbidity and in-hospital complications.

## Methods

### Study design

The Myocardial Ischaemia National Audit Project (MINAP) is a national registry which contains data from patients with an acute coronary syndrome admitted to all 230 National Health Service (NHS) hospital trusts in England and Wales, its methodology having previously been extensively described.[18-21] MINAP has National Patient Information Advisory Group and Central Office for Research Ethics Committees approval for individual patient anonymous linkage for mortality. The current study obtained the ethical approval from the Faculty of Medicine & Health Sciences Research Ethics Committee, University of East Anglia.

### Study population

We used records of admissions between 1st January 2006 and 31st December 2010 (the latest download available from MINAP at the time of our research grant award) for patients documented as having an ACS with a positive troponin blood test who were discharged alive. Data were cleaned by a statistician using *a priori* definitions and a data usage manual written jointly by clinical academics in cardiology and geriatric medicine (MJZ and PKM). We further validated variables using cross-checks with other data fields. The study sample consisted of 86,183 NSTEMI patients for the baseline table. The diagnosis of NSTEMI is made by the local clinician using their judgement of presenting symptoms and requiring elevated blood troponin concentration with or without electrocardiographic changes consistent with ischaemia. We did not seek to examine patients with STEMI (ST elevation myocardial infarction) due to its more clear management pathway regarding receipt of invasive coronary angiography (i.e., decision to perform primary coronary revascularisation in these patients is an instantaneous one made on the basis of the first ECG) - thus, the vast majority of these patients get specialist cardiologist input. As we have previously reported, the ratio of NSTEMI to STEMI increases significantly with age, with 74% of ACS in patients aged ≥85 being NSTEMI compared to only 44% in patients <65 years.[9] We had data on receipt of cardiologist care for 72,216 of which 1,363 were missing data for Strategic Health Authority (SHA) leaving 70,853 patients for the final two tables.

### Study variables

The MINAP registry dataset has pre-defined variables and we examined secondary prevention medicine therapy usage by using data on receipt of aspirin, ACE inhibitor or statin on discharge. MINAP has co-morbidity data limited to chronic kidney disease (CKD), congestive cardiac failure (CCF), peripheral vascular disease (PVD), cerebrovascular disease and chronic obstructive pulmonary disease (COPD) which were taken from past medical history. In-patient significant bleeding was defined as any bleed recorded by the clinician during the admission as well as retroperitoneal and intracranial haemorrhage. Other markers of disease severity conditions used in the prospective analyses were the in-hospital clinical events of re-infarction, cardiac arrest and having an abnormal electrocardiogram ((ECG), e.g.

ST or T wave changes or left bundle branch block). We used MINAP data on whether the patient had received cardiological care during the course of the admission and planned follow-up. Thus the assignment of a patient receiving cardiology versus generalist care was delineated using two points of data capture. Cardiovascular risk factors used in the analyses were those available within MINAP - current smoking, known diabetes mellitus and known hypertension. All hospitals that input data into MINAP are capable of providing in-house specialist care for NSTEMI patients, though not all have on-site cardiac catheterisation facilities, data not available in MINAP. To account for potential regional differences in care, we used MINAP data on the patient's Strategic Health Authority, the regional body that oversees the provision of healthcare across a given region within the National Health Service of England and Wales. All patients in MINAP are followed up for their date of all-cause death through linkage to the National Health Service Central Registry using a unique number, and this was the outcome in the study.

**Statistical analysis**

We examined baseline patient characteristics, split by cardiologist and generalist care, in terms of age/sex, cardiovascular risk factors and co-morbidities. We then examined baseline data further to assess the association of cardiologist care on receipt of treatments compared to generalist care by age group via logistic regression analyses, and then adjusted for specific co-morbidities or peri-admission complications that might affect receipt of these treatments (receipt of ACE inhibitors adjusted for chronic kidney disease; receipt of aspirin adjusted for in-patient bleeding; receipt of beta-blockers adjusted for COPD). We then used a fully adjusted model to assess further the association between cardiologist care and receipt of treatments compared to generalist care. Odds ratios were adjusted for age as a continuous variable within each age group, sex and for receipt of these treatments on arrival (data available for all treatments except aspirin).

To investigate the association of cardiologist care on time to death, we constructed Cox proportional hazards regression models adjusted for sex, then in turn for cardiovascular risk factors (diabetes, hypertension and smoking), co-morbidities (previous chronic kidney disease, cerebrovascular disease, peripheral vascular disease, chronic obstructive pulmonary disease and congestive cardiac failure), receipt of secondary prevention (ACE inhibitor, statin, aspirin, b-blocker) and case severity variables (re-infarction, bleeding, cardiac arrest and abnormal ECG) before using a full model to assess if these potential confounders affected the association between cardiologist care and death, by age group. Outcomes were analysed at 30 days, 1 year and at censoring.

All regression models (both crude and adjusted) included Hubert-White robust adjustment for intra-cluster correlation of outcomes within Strategic Health Authorities and all met the assumption of proportional hazards.

Analyses were performed using Stata SE, version 11.0 (Stata, College Station, Texas).

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## Results

The mean age of the cohort was 72.0 years (SD 13.0 years), with 14,685 aged 85 or over. The mean follow-up was 2.13 years (SD 1.40). Less than 3% of patients (and less than 5% of patients aged 75-84) died in hospital. In the whole baseline cohort population, older patients received less cardiologist care (70.2% of NSTEMI patients ≥85 compared to 94.7% of patients <65). Patients' baseline characteristics by age group and cardiologist/generalist care are shown in Table 1. The proportion of men reduced with older age group for both types of care, from 76.5% in patients <65 years old to 44.7% in patients ≥85 years old under a cardiologist. For both types of care, the proportion of smokers reduced with increasing age group, whereas both diabetes and hypertension demonstrated an inverted U-shaped relationship. Past history of chronic kidney disease, congestive cardiac failure and cerebrovascular disease rose with increasing age group. When compared side-by-side, those under generalist care had higher levels of co-morbidities across all pathologies and age groups. With older age, the risk of bleeding during the course of admission with NSTEMI increased.

The association of cardiologist care on receipt of treatments and presence of co-morbidity compared to generalist care by age group is depicted in Table 2. Cardiologist care resulted in receipt of more secondary prevention in all age groups, though with increased age less secondary prevention was given by both cardiologists and generalists. We then sought to investigate for any confounding effect of specific co-morbidities or peri-admission complications on the association of cardiologist care and potentially contra-indicated prescribing on discharge (e.g. ACE inhibitor in CKD), by age group. There were only slight attenuations in the odds ratios of the receipt of these secondary prevention medications when these specific potential contra-indications to prescription were adjusted for (e.g. OR for receipt of ACE inhibitor from cardiologist care dropping from 1.44 to 1.38 in patients under 65, from 1.50 to 1.38 in patients ≥85 years old, after adjusting for age, sex, ACE inhibitor on admission and chronic kidney disease). However in the full models, much of the reduced treatment in those under generalists was explained away. In patients under 65, the crude OR of 1.44 for receipt of ACE inhibitor comparing cardiologist to generalist care became non-significant (1.07 (0.90, 1.27)) and this trend was observed across the age groups though just not becoming significant in the other groups. In the aspirin and statin groups, fully- adjusted models rendered all the ORs non-significant. For beta-blockers, the fully adjusted model attenuated the relationship, but cardiologists still tended to prescribe these more than generalists across all age groups.

We then investigated the association of cardiologist care on time to death (table 3). In all age groups, receiving cardiologist care was associated with a decreased risk of death, but the benefit reduced incrementally with older age group (e.g. sex-adjusted hazard ratio (HR) 0.52 (0.45,0.61) in patients aged <65, 0.78 (0.72,0.84) in patients aged ≥85). Adjusting for cardiovascular risk factors and case severity did not significantly alter the HRs for survival. When adjusting for co-morbidities, the HR attenuated in patients aged <65 where the HR rose from 0.52 to 0.62. Adjusting for receipt of secondary prevention led to minor changes of the association in all age groups, but most marked in patients aged ≥85 where the HR rose from 0.78 to 0.87. In the full model, there remained significant statistical differences between cardiologist care and generalist care on reduction in death rates in all age groups, though this benefit reduced incrementally with older age group (adjusted hazard ratio (HR) 0.58 (0.49,0.68) aged <65; 0.87 (0.82,0.92) aged ≥85). When examining 30 day outcomes, receipt of secondary prevention fully explained away the survival difference between cardiologist care and generalist care in patients aged ≥85 (HR 1.06 (0.97,1.16), table S1).

**Discussion**

Using a national ACS registry cohort that reflects real-world clinical practice in England and Wales, we found older patients with NSTEMI received less cardiologist care, and that cardiologists prescribed more secondary prevention across all age groups compared to generalists. Adjustments for specific treatment contra-indications that might lead to both a cardiologist and generalist not prescribing a particular moderation were not able to explain this reduced receipt of secondary prevention medication observed in patients who did not receive cardiologist care but in the fully adjusted models, much of the reduced treatment in those under generalists was explained away. Any survival benefit associated with cardiology care was attenuated firstly with increased age, and then in older age groups by adjusting for receipt of secondary prevention, and in younger age groups by adjusting for co-morbidity. However, the long-term survival benefit associated with cardiology care was not explained away by receipt of more secondary prevention, though receipt of secondary prevention may equalise outcomes at 30 days.

We have previously shown that older patients with NSTEMI receive less secondary prevention medication than younger patients;[9] we add to those findings here by showing that the oldest patients are less likely to see a cardiologist (though a majority did still see one). Furthermore, older patients have more co-morbidity and in our fully-adjusted model with comprehensive adjustment we could explain away the reduced receipt of secondary prevention medication observed in all patients who did not receive cardiologist care, including both younger and older ones. This implies that the observed deficiency in indicated care in patients across the board by generalists may be appropriate – younger patients under generalists must have a lot of co-morbidity to not come under cardiology care, whilst older patients with their higher co-morbidity on admission are more likely to be put under a generalist.

In all age groups, receiving cardiologist care leads to better outcomes, but we demonstrated that the benefit of being under a cardiologist was attenuated significantly when adjusted for receipt of secondary prevention medication, particularly for shorter (30 day) outcomes. This illustrates that it is these treatments that make the biggest impact on survival in this age group, a group in which the failure to provide such treatments is potentially more likely to be associated with higher mortality than in younger groups (a risk-treatment paradox); this concept of relative survival has been previously described in this cohort.[22] In our study these treatments do not fully close the gap in long-term survival between cardiologist and generalist care and it is likely that those were cared for by generalists are sicker, frailer and have more advanced disease; that may thus determine the long-term survival gap and overcome any benefit secondary prevention medication may have over a long follow-up period. Thus though cardiologist care was associated with lower mortality at all ages, this effect decreased with older age probably because it is harder to prevent death in older people even with specialist care. This finding is of particular relevance to the generalist, given the ratio of NSTEMI to STEMI increases significantly with age, and they may be increasingly looked to for caring for these patients. More detailed phenotyping of the patient may have explained the long-term survival gap further.

Considering the multiple needs of older patients, the care of the oldest patients under a generalist such as a geriatrician may be wholly appropriate but perhaps with a need for a systematic specialist care process to guide generalists on the usage of guideline-supported secondary prevention therapies, at least in the short-term. This may provide some support to increased use of medicines in the older patient, in whom polypharmacy is often of harm.[23] Thus we do not demonstrate here that care under a cardiologist should be mandated in the older patient with NSTEMI and in fact show that any under-treatment by generalists in the crude models is likely to be appropriate as they are mostly explained away by adjustments for co-morbidity. What we cannot say with any level of confidence from the current study is which older ACS patient should get specialist management - chronological age is not biological age and we cannot advocate an age cut-off for specialist care from our results. Furthermore, all-cause mortality, the only outcome available within MINAP, may not be as relevant an outcome to the older patient with ACS as future quality of life, symptom control, tolerance to medication, disability, repeated hospitalisation and return to independent living might be.[16] Health-related quality of life may in fact be more improved in older patient groups after coronary revascularisation.[24] For this, the use of measures such as frailty, perhaps in an easy-to-measure guise[25] for the post-ACS patient, may guide the clinician better as to the appropriateness of more intensive care in the older patient following presentation with ACS; they may represent more relevant prognostic indicators in the older patient following ACS[26] when also taking into consideration that the relative potency of more widely-used prognostic measures such as troponin has been reported to attenuate with increased age.[27]

*Strengths and Limitations*

Our data span five years and accrues large numbers of patients across all age groups that are representative of a country's clinical practice. Unlike in clinical trials, the representation of the oldest people (aged 85 and over) in our study is a major strength of the observational study design. We appreciate however the selection bias that may have operated in our study, and in such a registry cohort design it is impossible to eliminate this bias that occurs on allocation of different treatments, care pathways that are relevant to the clinicians' perceived prognosis of the patient. However, seeing that the association between lack of cardiologist care and worse survival was attenuated markedly by receipt of guideline-supported secondary prevention, our study design of real-world clinical practice is important in demonstrating the appropriate selection 'triage' of patients into pathways that are of relevance to improve their prognosis. The fact that we show that even with specialist cardiologist care preventing death in older people is hard to do is of clear clinical relevance, and a finding that would be difficult to replicate in a clinical trial design, where it would be unethical to randomise an older patient to non-receipt of secondary prevention or specialist cardiologist care. Hence, our study design is appropriate to examine the receipt-of-care questions we pose of it.

Co-morbidity data were limited (e.g. no data on cancer, dementia etc) and were defined by past medical history and not by laboratory data or other objective parameters; thus we were unable to explore in greater detail reasons underlying the differences in receipt of care and on survival; there may exist unmeasured confounding particularly since cardiologists were more likely to care for younger patients with fewer comorbidities, and there could have been ascertainment bias which could confound the results. As a registry data we do not have information on whether a procedure or treatment was based on patient preference and this should be investigated in future studies to better understand the relationships observed in this study. We were unable to conclusively examine whether data in MINAP on cardiologist care meant that the patient was the reponsibility of the cardiologist, or whether cardiological input was provided whilst the patient remained the reponsibility of a general physican. The statistical analyses could not control for dosages of medications, and thus we made the assumption that secondary prevention when prescribed was at an optimal dose for that patient.

Though it collects data from all 230 hospitals in England and Wales, missingness remains a weakness of registry data. However, previous published imputation analyses on the MINAP dataset by the lead author[28] have not significantly altered effect sizes and imply that missingness in MINAP is at random, whilst work by others has also shown that the level of missingness of data in MINAP does not alter regional standardised mortality ratios.[29] Data on admission cholesterol level/past history of dyslipidaemia and receipt of clopidrogrel at discharge were also not usable due to failure to pass validation checks and high levels of missingness (over 40% for clopidrogrel).

Finally, cause-specific mortality is not available within MINAP, and most of studies in this field including key ones like the GRACE registry similarly report all-cause death as we have done.[30-31] Importing cause of death into registries like MINAP remains hard to do.

*Conclusion*

We found that among patients with NSTEMI, older patients are less likely to see a cardiologist. Cardiologists are more likely to prescribe secondary prevention medication than generalists at all ages but this can be mostly explained away by increased co-morbidity in patients who remain under generalist care. Patients treated by cardiologists are less likely to die, with co-morbidities and secondary prevention medication explaining only part of this mortality difference, though the benefit of specialist care is less as the patient ages. Even with specialist cardiologist care, it may be that it is simpler harder to prevent death in older people; more research is needed to determine which older patients would clearly benefit from cardiologist care to ensure optimal and relevant outcomes. Our data here show that at present, generalist care may be wholly appropriate in the older NSTEMI patient with multiple co-morbidities.

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*Conflicts of Interest*

The authors have no conflicts of interest to declare.

*Author Contributions*

MJZ had the original idea, developed with PKM. MJZ drafted the initial analysis plan and carried out the initial statistical analyses. ABC and SS were involved in further analysis and statistical checks. MOB provided senior statistical support. RF, TS and MOB were involved in further discussion and interpretation. All authors contributed to further drafts and analyses, and were involved in the discussion and interpretation.

*Sponsor's Role*

The views expressed within this article are those of authors' and not necessarily those of the Trust.

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**Graphics**

*Table legends*

Table 1 Patients' Baseline Characteristics, Co-morbidities and Receipt of Treatment

Table 2 Association of Cardiologist Care with Receipt of Treatments Compared to Generalist Care, by Age Group

Table 3 Effect of Cardiologist Versus Generalist Care on Risk of All-cause Death Year by Age Group

Table S1 Effect of Cardiologist Versus Generalist Care on Risk of All-cause Death Within 30 days and One Year by Age Group

Table 1 Patients' Baseline Characteristics and Co-morbidities by Cardiologist/Generalist Care

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Age group** | **<65** | | **65-74** | | **75-84** | | **≥85** | |
| *Care* | Cardiologist | Generalist | Cardiologist | Generalist | Cardiologist | Generalist | Cardiologist | Generalist |
| N (%) | 20,736 (94.6) | 1,167 | 15,687 (91.9) | 1,392 | 17,729 (84.5) | 3,260 | 8,588 (70.1) | 3,657 |
| Age, years (mean, SD) | 54.9 (7.4) | 55.4 (7.5) | 70.1 (2.9) | 70.6 (2.8) | 80.0 (2.8) | 80.5 (2.7) | 88.7 (3.1) | 89.8 (3.6) |
| Men, n (%) | 15,868 (76.5) | 845 (72.4) | 10,460 (66.7) | 870 (62.5) | 10,303 (58.1) | 1,638 (50.2) | 4,099 (47.7) | 1,415 (38.7) |
| **Cardiovascular risk factors** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Current smoker, n (%) | 9,260 (44.7) | 498 (42.7) | 3,251 (20.7) | 297 (21.3) | 1,830 (10.3) | 396 (12.2) | 387 (4.5) | 180 (4.9) |
| Diabetes, n (%) | 3,907 (18.8) | 235 (20.1) | 4,470 (28.5) | 417 (30.0) | 4,814 (27.2) | 955 (29.3) | 1,718 (20.0) | 674 (18.4) |
| Hypertension, n (%) | 8,981 (43.3) | 497 (42.6) | 9,018 (57.5) | 765 (55.0) | 11,044 (62.3) | 1,851 (56.7) | 5,168 (60.2) | 2,003 (54.8) |
| **Co-morbidities** | | | | | | | | |
| Congestive cardiac failure, n (%) | 459 (2.2) | 40 (3.4) | 930 (5.9) | 126 (9.0) | 1,702 (9.6) | 471 (14.4) | 1,198 (14.0) | 600 (16.4) |
| Chronic kidney disease, n (%) | 568 (2.7) | 54 (4.6) | 930 (5.9) | 133 (9.6) | 1,722 (9.7) | 409 (12.6) | 973 (11.3) | 449 (12.3) |
| Cerebrovascu | 860 (4.2) | 59 (5.1) | 1,552 (9.9) | 202 (14.5) | 2,248 (12.7) | 582 (17.9) | 1,227 (14.3) | 652 (17.8) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| lar disease, n (%) | | | | | | | | |
| Peripheral vascular disease, n (%) | 665 (3.2) | 62 (5.3) | 1,040 (6.6) | 125 (9.0) | 1,282 (7.2) | 246 (7.6) | 479 (5.6) | 160 (4.4) |
| Chronic obstructive pulmonary disease, n (%) | 2,472 (11.9) | 189 (16.2) | 2,945 (18.8) | 367 (26.4) | 3,346 (18.9) | 796 (24.4) | 1,266 (14.7) | 576 (15.8) |
| In-patient bleeding, n (%) | 155 (0.8) | 12 (1.0) | 213 (1.4) | 30 (2.2) | 346 (2.0) | 92 (2.8) | 157 (1.8) | 127 (3.5) |

Table 2 Association of Cardiologist Care with Receipt of Treatments Compared to Generalist Care, by Age Group

| **Age group** | **<65** | **65-74** | **75-84** | **≥85** |
|---|---|---|---|---|
| **Type of care** | | | | |
| Cardiologist | 20,362 (94.7) | 15,378 (91.9) | 17,392 (84.5) | 8,441 (70.2) |
| Generalist | 1,139 | 1,361 | 3,193 | 3,587 |
| **Prescribed ACE inhibitor** | | | | |
| Cardiologist (%) | 15,081 (74.1) | 11,050 (71.9) | 11,850 (68.1) | 5,171 (61.3) |
| Generalist (%) | 760 (66.7) | 849 (62.4) | 1,822 (57.1) | 1,832 (51.1) |
| Crude OR | 1.44 (0.94,2.21) | 1.53 (1.26,1.85) | 1.61 (1.42,1.82) | 1.50 (1.35,1.68) |
| Age/Sex/ACEi on admission adjusted OR | 1.40 (0.91,2.16) | 1.53 (1.24,1.90) | 1.58 (1.38,1.82) | 1.39 (1.23,1.57) |
| Age/Sex/ACEi on admission/CKD adjusted OR | 1.38 (0.89,2.14) | 1.49 (1.21,1.83) | 1.56 (1.35,1.79) | 1.38 (1.21,1.57) |
| Fully adjusted | 1.07 (0.90,1.27) | 1.36 (1.10,1.67) | 1.33 (1.15,1.53) | 1.15 (1.04,1.27) |
| **Prescribed aspirin** | | | | |
| Cardiologist (%) | 16,860 (82.8) | 12,239 (79.6) | 13,480 (77.5) | 6,582 (78.0) |
| Generalist (%) | 879 (77.2) | 1,011 (74.3) | 2,258 (70.7) | 2,572 (71.7) |
| Crude | 1.44 (0.85,2.45) | 1.34 (1.07,1.67) | 1.43 (1.31,1.54) | 1.38 (1.17,1.64) |
| Age/sex adjusted | 1.44 (0.85,2.44) | 1.33 (1.07,1.67) | 1.42 (1.18,1.69) | 1.37 (1.15,1.63) |
| Age/sex/bleeding adjusted | 1.44 (0.84,2.44) | 1.33 (1.06,1.67) | 1.40 (1.17,1.68) | 1.34 (1.12,1.61) |
| Fully adjusted | 1.05 (0.77,1.44) | 1.08 (0.90,1.29) | 1.08 (0.94,1.24) | 1.04 (0.92,1.18) |

| | | | | |
|---|---|---|---|---|
| **Prescribed b-blockers** | | | | |
| Cardiologist (%) | 14,969 (73.5) | 10,294 (66.9) | 11,233 (64.6) | 5,304 (62.8) |
| Generalist (%) | 719 (63.1) | 752 (55.3) | 1,682 (52.7) | 1,853 (51.7) |
| Crude | 1.62 (1.17,2.25) | 1.64 (1.36,1.98) | 1.65 (1.44,1.89) | 1.58 (1.36,1.83) |
| Age/sex/b-blocker on admission adjusted | 1.57 (1.13,2.18) | 1.53 (1.26,1.85) | 1.57 (1.37,1.81) | 1.43 (1.26,1.63) |
| Age/sex/ b-blocker on admission/COPD adjusted | 1.53 (1.08,2.15) | 1.44 (1.18,1.75) | 1.52 (1.32,1.76) | 1.43 (1.25,1.63) |
| Fully adjusted | 1.35 (1.04,1.76) | 1.29 (1.15,1.43) | 1.28 (1.14,1.44) | 1.20 (1.04,1.37) |
| **Prescribed statin** | | | | |
| Cardiologist (%) | 16,891 (83.0) | 12,491 (81.2) | 13,847 (79.6) | 6,414 (76.0) |
| Generalist (%) | 883 (77.5) | 1,055 (77.5) | 2,340 (73.3) | 2,348 (65.5) |
| Crude | 1.45 (0.83,2.54) | 1.23 (0.93,1.64) | 1.38 (1.09,1.75) | 1.51 (1.27,1.80) |
| Age/sex/statin on admission adjusted | 1.44 (0.83,2.52) | 1.24 (0.93,1.65) | 1.37 (1.09,1.73) | 1.41 (1.17,1.70) |
| Fully adjusted | 1.13 (0.74,1.73) | 0.90 (0.71,1.13) | 1.00 (0.79,1.27) | 1.11 (0.92,1.33) |

OR: odds ratio (95% CI) for cardiologist vs. generalist care within each age group.

CRF - chronic renal failure; CKD - chronic kidney disease; COPD - chronic obstructive pulmonary disease

Fully adjusted - adjusted for sex, diabetes, hypertension and smoking; in-hospital cardiac arrest, in-hospital re-infarction, abnormal ECG and in-hospital bleeding; chronic kidney disease, cerebrovascular disease, peripheral vascular disease, chronic obstructive pulmonary disease and congestive cardiac failure; receipt of other secondary prevention (three of statin, aspirin, b-blocker, ACE inhibitor excluding the treatment under investigation in the model) at discharge, and receipt of treatment under investigation in that model on admission

Data available for all treatments on arrival except aspirin

Table 3 Effect of Cardiologist Versus Generalist Care on Risk of All-cause Death by Age Group

| **Age in years** | HR (95%CI)[1] | HR (95%CI)[2] | HR (95%CI)[3] | HR (95%CI)[4] | HR (95%CI)[5] | HR (95%CI)[6] |
|---|---|---|---|---|---|---|
| *Adjusted for* | *Sex* | *Cardiovascular risk factors* | *Disease severity* | *Co-morbidity* | *Secondary prevention* | *All* |
| **<65** | 0.52 (0.45,0.61) | 0.52 (0.45,0.61) | 0.50 (0.42,0.59) | 0.62 (0.49,0.77) | 0.56 (0.46,0.68) | 0.58 (0.49,0.68) |
| **65-74** | 0.47 (0.40,0.57) | 0.48 (0.41,0.57) | 0.48 (0.40,0.57) | 0.54 (0.47,0.61) | 0.50 (0.42,0.60) | 0.55 (0.48,0.63) |
| **75-84** | 0.57 (0.49,0.66) | 0.58 (0.50,0.67) | 0.56 (0.48,0.64) | 0.62 (0.53,0.71) | 0.60 (0.51,0.69) | 0.63 (0.54,0.72) |
| **≥85** | 0.78 (0.72,0.84) | 0.78 (0.73,0.84) | 0.77 (0.72,0.82) | 0.79 (0.73,0.86) | 0.87 (0.82,0.91) | 0.87 (0.82,0.92) |

Cox regression model hazard ratio, HR (95% CI) for cardiologist versus generalist care

1 Adjusted for sex

2 Adjusted for sex, diabetes, hypertension and smoking

3 Adjusted for sex, in-hospital cardiac arrest, in-hospital re-infarction, abnormal ECG and in-hospital bleeding

4 Adjusted for sex, chronic kidney disease, cerebrovascular disease, peripheral vascular disease, chronic obstructive pulmonary disease and congestive cardiac failure

5 Adjusted for sex, receipt of ACE inhibitor, statin, aspirin, b-blocker

6 Adjusted for all the above

Table S1 Effect of Cardiologist Versus Generalist Care on Risk of All-cause Death Within 30 days and One Year by Age Group

| **Age in years** | HR (95%CI)[1] | HR (95%CI)[2] | HR (95%CI)[3] | HR (95%CI)[4] | HR (95%CI)[5] | HR (95%CI)[6] |
|---|---|---|---|---|---|---|
| *Adjusted for* | *Sex* | *Cardiovascular risk factors* | *Disease severity* | *Co-morbidity* | *Secondary prevention* | *All* |
| **<65** | | | | | | |
| 30 days | 0.52 (0.35,0.77) | 0.53 (0.36,0.78) | 0.47 (0.33,0.66) | 0.61 (0.41,0.89) | 0.62 (0.38,1.02) | 0.60 (0.42,0.85) |
| 1 year | 0.46 (0.37,0.57) | 0.46 (0.38,0.57) | 0.43 (0.35,0.53) | 0.76 (0.70,0.83) | 0.50 (0.38,0.65) | 0.51 (0.41,0.63) |
| **65-74** | | | | | | |
| 30 days | 0.36 (0.27,0.48) | 0.36 (0.27,0.49) | 0.37 (0.29,0.49) | 0.40 (0.30,0.53) | 0.36 (0.27,0.50) | 0.44 (0.33,0.58) |
| 1 year | 0.44 (0.37,0.52) | 0.45 (0.38,0.52) | 0.44 (0.37,0.52) | 0.54 (0.42,0.69) | 0.46 (0.38,0.56) | 0.52 (0.45,0.60) |
| **75-84** | | | | | | |
| 30 days | 0.54 (0.42,0.68) | 0.55 (0.43,0.69) | 0.50 (0.41,0.62) | 0.57 (0.45,0.73) | 0.57 (0.49,0.66) | 0.58 (0.50,0.66) |
| 1 year | 0.56 (0.48,0.66) | 0.57 (0.49,0.67) | 0.55 (0.47,0.63) | 0.50 (0.44,0.56) | 0.59 (0.51,0.70) | 0.63 (0.54,0.73) |
| **≥85** | | | | | | |
| 30 days | 0.82 (0.68,1.00) | 0.83 (0.69,1.01) | 0.80 (0.66,0.98) | 0.83 (0.68,1.02) | 1.06 (0.97,1.16) | 0.99 (0.89,1.11) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 year | 0.77 (0.71,0.84) | 0.77 (0.71,0.84) | 0.76 (0.70,0.83) | 0.79 (0.72,0.86) | 0.88 (0.82,0.95) | 0.88 (0.80,0.95) |

Cox regression model hazard ratio, HR (95% CI) for cardiologist versus generalist care

1 Adjusted for sex

2 Adjusted for sex, diabetes, hypertension and smoking

3 Adjusted for sex, in-hospital cardiac arrest, in-hospital re-infarction, abnormal ECG and in-hospital bleeding

4 Adjusted for sex, chronic kidney disease, cerebrovascular disease, peripheral vascular disease, chronic obstructive pulmonary disease and congestive cardiac failure

5 Adjusted for sex, receipt of ACE inhibitor, statin, aspirin, b-blocker

6 Adjusted for all the above